

Partnership for Science & Engineering Practices

Protocol for Unit Enhancement of Explanation and Argumentation- Grades 6-8

Part 1 Overview of Explanation and Argumentation in NGSS

Read the text below as a reminder of the practices of explanation and argumentation in grades 6-8.

Also examine the way that explanation and argumentation are present in the NGSS performance expectations.

Practice 6 Constructing Explanations and Designing Solutions:

The goal of science is to construct explanations for the causes of phenomena. Students are expected to construct their own explanations, as well as apply standard explanations they learn about from their teachers or reading. The Framework states the following about explanation:

“The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.”(NRC Framework, 2012, p. 52)

An explanation includes a claim that relates how a variable or variables relate to another variable or a set of variables. A claim is often made in response to a question and in the process of answering the question, scientists often design investigations to generate data. The goal of engineering is to solve problems. Designing solutions to problems is a systematic process that involves defining the problem, then generating, testing, and improving solutions. This practice is described in the Framework as follows.

Asking students to demonstrate their own understanding of the implications of a scientific idea by developing their own explanations of phenomena, whether based on observations they have made or models they have developed, engages them in an essential part of the process by which conceptual change can occur.

Explanation in Grade 6-8

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena.
- Construct an explanation using models or representations.
- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
- Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for realworld phenomena, examples, or

events.

- Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.

Practice 7 Engaging in Argument from Evidence

The study of science and engineering should produce a sense of the process of argument necessary for advancing and defending a new idea or an explanation of a phenomenon and the norms for conducting such arguments. In that spirit, students should argue for the explanations they construct, defend their interpretations of the associated data, and advocate for the designs they propose. (NRC Framework, 2012, p. 73)

Argumentation is a process for reaching agreements about explanations and design solutions. In science, reasoning and argument based on evidence are essential in identifying the best explanation for a natural phenomenon. In engineering, reasoning and argument are needed to identify the best solution to a design problem. Student engagement in scientific argumentation is critical if students are to understand the culture in which scientists live, and how to apply science and engineering for the benefit of society. As such, argument is a process based on evidence and reasoning that leads to explanations acceptable by the scientific community and design solutions acceptable by the engineering community.

Argument in science goes beyond reaching agreements in explanations and design solutions. Whether investigating a phenomenon, testing a design, or constructing a model to provide a mechanism for an explanation, students are expected to use argumentation to listen to, compare, and evaluate competing ideas and methods based on their merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims.

Argumentation in Grade 6-8

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts.
- Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.
- Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.
- Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints.

NGSS Performance Expectations with Explanation & Argumentation connections

(These are here as a reference so you can see how some NGSS Performance Expectations contain integrated explanation and argumentation practices)

____ **MS-PS2-4** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects

____ **MS-PS3-5** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

____ **MS-LS1-3** Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

____ **MS-LS1-4** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

____ **MS-LS1-5** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

____ **MS-LS1-6** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

____ **MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

____ **MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

____ **MS-LS4-2** Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

____ **MS-LS4-4** Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

____ **MS-ESS1-4** Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.

____ **MS-ESS2-2** Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

___ **MS-ESS3-1** Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

___ **MS-ESS3-4** Construct an argument supported by evidence for how increases in human population and per-capital consumption of natural resources impact Earth's systems.

Use the questions below to guide your thinking about how to effectively integrate the teaching of **Scientific Explanation and Argumentation** writing into your instructional materials.

Part 2. Identify the High Leverage Lesson	Facilitator NOTES
<p>Step 1:Examining your instructional material- Science Concepts identify the science concepts and authentic opportunities for engaging in explanation. What are the important science concepts? What are the relevant WA Science Standards in the lesson/unit?</p>	<p>Invite the STEM Professional to discuss:</p> <ul style="list-style-type: none">• the important science concepts in the identified activities• how explanation and argumentation present themselves in the “science world” <p>A starting place has already been provided for each kit. Start in these places and confirm whether an opportunity is present.</p>
<p>Step 2: Examining your instructional material- Practices Where are the authentic opportunities for students to make claims, gather evidence, and use scientific reasoning (related to the important science concepts)? What opportunities might students have to construct explanations and engage in argumentation?</p>	<p>Consider opportunities for students to make observations and collect data with the materials they have</p>

Part 3. Clarify the Explanation Opportunity	
Step 1: Design the Question The wording of the question is very important and helps determine the difficulty and the level of complexity of the resulting explanation. Is there an opportunity to collect evidence to answer the question? Does the question require the use of a scientific concept in the reasoning? Example- Thinking about the “openness” of a question: Does water cause a seed to begin growing? (simple) What does a seed need to begin growing? (complex)	This initial examination of the question is critical and will determine whether there is an enhancement opportunity and if so, how much supplementation will be required.
Step 2: Generate a Range of Claims Brainstorm a range of claims from a high quality claim to the minimum acceptable claim. Include some incorrect or naive claims that some learners may have.	
Step 3: Identify Acceptable Evidence What evidence will students use to support their claim? How much evidence should students use? What incorrect evidence may some students be tempted to use? Why?	
Step 4: Identify Reasoning What type of reasoning might students use to connect their evidence to the claim? What science concepts (principles) will students be using?	If there is no science concept necessary in the reasoning then this may not be an ideal context for explanation and argumentation enhancement

Step 5: Considering Rebuttal (optional) What might a student use as a rebuttal to support the claim? Do you feel students are ready for this element of the CER(R) framework? Why/why not? How might you support students in crafting a rebuttal statement in their explanation?	
Part 4: Develop the Assessment Task (performance task)	
Step 1: Select scientific explanation level of complexity What variation of the CER framework will you use? See p. 118 WYE	
Step 2: Create Learning Performances see p. 121 WYE	
Step 3: Write the Assessment Task see p. 122 WYE	
Step 4: Develop Specific Rubric see p. 126 WYE	
Part 5: Plan the Learning Sequence	Now that you have the assessment task identified, work backwards to plan a learning sequence for scientific explanation writing (and talking).
Step 1: Identify a Learning Sequence	Reminder: We are not building an

<p>Use some or all of the strategies below to create a Learning Sequence.</p> <p>How might you:</p> <ul style="list-style-type: none"> • Introduce the CER framework • Model and critique explanations • Provide a rationale for explanations • connect to everyday explanations • provide feedback to students on their explanations <p>How do you want to order your existing instructional activities for students to build evidence for their claims?</p>	<p>entire unit on Claim, Evidence, Reasoning. Be on the lookout for groups who are spending too much time and energy here.</p>
<p>Step 2: Identify CER Tools and Strategies</p> <p>- Which of the CER Tools & Strategies will be the most useful for supporting learners leading up to the performance task? Why do you think so?</p>	
<p>Step 3: Unburden the Curriculum</p> <p>What lessons or activities might you remove to make room for the enhancements?</p>	
<p>Step 4: Supporting All Learners</p> <p>How can we tailor instruction to students who may have special needs, interests, and abilities?</p> <p><i>(Explanation and Argumentation have a strong connection to language learning- How will you support English Language Learners in the speaking, listening, and writing of Claim, Evidence, and Reasoning?)</i></p>	
<p>Step 5: Additional Notes and Resources</p> <p>What additional information do you want to make sure and remember when you are ready to teach these lessons?</p> <p>What other resources might be useful for supporting teachers and/or learners during these lessons?</p>	

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